

Researches on Explosives. Part III. Supplementary Note

Andrew Noble

Proc. R. Soc. Lond. A 1905 **76**, 512-514

doi: 10.1098/rspa.1905.0058

Email alerting service

Receive free email alerts when new articles cite this article - sign up in the box at the top right-hand corner of the article or click [here](#)

To subscribe to *Proc. R. Soc. Lond. A* go to: <http://rspa.royalsocietypublishing.org/subscriptions>

Researches on Explosives. Part III.—Supplementary Note.

By Sir ANDREW NOBLE, Bart., K.C.B., F.R.S., F.R.A.S.

(Received September 28, 1905.)

Since communicating to the Royal Society my Researches on Explosives, Part III, I have succeeded in obtaining the paper* by Messrs. Holborn and Austin on the Specific Heat of Gases at High Temperatures.

Their attention has been specially directed to carbonic anhydride, and their researches show a considerable (but rapidly decreasing) increment in the specific heat of CO_2 with increase of temperature.

If we suppose the same law of increment which appears to rule up to 800°C. to remain unaltered up to 1300°C. , the increments at that temperature would appear to vanish, and if this be so I find that the specific heat of CO_2 , at constant volume, should be taken at 0.2111.

I have therefore recalculated the specific heats given in my recent researches, the specific heats, at constant volume, which I have used being as follow:—

CO_2 .	CO.	H.	CH_4 .	N.	$\text{H}_2\text{O.}$
0.2111	0.176	2.411	0.470	0.175	0.368

and the recalculated specific heats of the exploded gases at the various densities come out as given below:—

For Cordite.

$D = 0.50.$ 0.24454	$D = 0.40.$ 0.24614	$D = 0.30.$ 0.24691	$D = 0.25.$ 0.24649	$D = 0.20.$ 0.24556	$D = 0.15.$ 0.24611
		$D = 0.10.$ 0.24434	$D = 0.05.$ 0.24515		

For M.D.

$D = 0.45.$ 0.24493	$D = 0.40.$ 0.24722	$D = 0.30.$ 0.24795	$D = 0.25.$ 0.24807	$D = 0.20.$ 0.24908	$D = 0.15.$ 0.25205
		$D = 0.10.$ 0.24841	$D = 0.05.$ 0.24882		

For Nitrocellulose.

$D = 0.45.$ 0.24737	$D = 0.40.$ 0.24716	$D = 0.30.$ 0.24843	$D = 0.29.$ 0.24766	$D = 0.22.$ 0.25068	$D = 0.20.$ 0.25065
		$D = 0.15.$ 0.25210	$D = 0.10.$ 0.25164	$D = 0.05.$ 0.24963	

* 'Preuss. Akad. Wiss. Berlin Sitz. Ber.,' vol. 5, p. 175.

and these figures are, I think, to be preferred to those given in the tables where the specific heats used were those which had been determined for temperatures under 200° C.

The temperatures of explosion I am about to give have been obtained by two different methods—firstly, by dividing the heats determined by the calorimeter by the specific heats just given, and, secondly, using the equation of dilatibility of gases, and determining the temperature from

$$t = \frac{p - p_0}{0.00367 p_0}, \quad (1)$$

where p is the pressure in atmospheres obtained from the explosion, and p_0 the pressure in atmospheres when the volume of gases generated is reduced to 0° C. and 760 mm. Bar. Pressure.

The differences of the results are very remarkable.

Taking for example cordite as an illustration, it will be seen that for the four highest densities given the temperatures derived from the two methods are but slightly different. At the higher density (0.5) the temperatures are 5275° C. and 5263° C., the higher being that derived from Equation (1); at density 0.45 the temperatures from the two methods are identical, at density 0.40 the temperatures are 4902° C. and 4970° C., the lower temperature being from Equation (1), but after density 0.35 the temperatures derived from Equation (1) fall very rapidly.

The same general results are observable in the other two explosives experimented with, and it should be noted that in all three explosives, at the highest densities, the temperatures given by Equation (1) are greater than those obtained by the second method.

On the other hand the temperatures obtained by dividing the heat obtained from the calorimeter by the specific heat do not greatly differ, and the least difference rests with the cordite.

The figures for the three explosives are given below, the temperatures obtained from $\frac{\text{units of heat}^*}{\text{specific heats}}$ being given in italics.

Cordite.

D = 0.50.	D = 0.45.	D = 0.40.	D = 0.35.	D = 0.30.	D = 0.25.
5275°	5090°	4902°	4710°	4480°	4165°
<i>5263</i>	<i>5090</i>	<i>4970</i>	<i>4860</i>	<i>4800</i>	<i>4770</i>
	D = 0.20.	D = 0.15.	D = 0.10.	D = 0.05.	
	3838°	3490°	3140°	2775°	
	<i>4760</i>	<i>4760</i>	<i>4790</i>	<i>4800</i>	

* Water gaseous.

M.D.

D = 0.45.	D = 0.40.	D = 0.35.	D = 0.30.	D = 0.25.	D = 0.20.
4718°	4494°	4200°	3920°	3585°	3240°
4624	4411	4215	4070	3945	3870
D = 0.15.	D = 0.10.	D = 0.05.			
2890°	2530°	2160°			
3840	3830	3860			

Nitrocellulose.

D = 0.45.	D = 0.40.	D = 0.35.	D = 0.30.	D = 0.25.	D = 0.20.
4305°	4007°	3630°	3320°	3060°	2835°
3954	3890	3795	3670	3530	3425
D = 0.15.	D = 0.10.	D = 0.05.			
2680°	2520°	2400°			
3345	3295	3255			

If these figures be examined it will be noted that in each explosive at the higher densities, the temperatures obtained by the two methods are nearly identical, those determined from Equation (1) being the higher, but as the density of charge is decreased the difference at the very low densities is remarkable; some of this difference is doubtless attributable to the slow burning under feeble pressures, and to the rapid cooling, by communication of heat to the walls of the explosive vessel during the ignition of the charge, but it is impossible to ascribe the whole difference to this cause, and I can only suggest that the explanation is to be sought in the probable dissociation of the carbonic anhydride and aqueous vapour at low pressures, this dissociation being prevented wholly or partially by the very high pressures at the higher densities.

Various substances such as carbon, metallic platinum, tantalum, osmium and titanium have been placed in the charge, and all have been more or less fused and volatilised during the small fraction of a second to which they were exposed to the maximum heat. Tantalum wire coiled on a steel wire became alloyed with the fused steel, taking up 14 per cent. Fe uniformly distributed, the Ta before the experiment being free from Fe.

A great part of the titanium was recovered in a fused crystalline condition.

Osmium and thin platinum foil were volatilised and thick sheet platinum was recovered in the form of a button.